SECTION I

SUBJECT AREA AND COURSE NUMBER: Chemistry 251

COURSE TITLE: Analytical Chemistry

UNITS: 5
Letter Grade or Credit/No Credit Option

CATALOG COURSE DESCRIPTION:

This is a course in quantitative analysis. Major topics include theory and practice of gravimetric and volumetric methods of chemical analysis and introduction to instrumental methods of analysis with a focus on precision and accuracy of experimental data. The target audience for Chem 251 is students majoring in chemistry or biochemistry and others who need the course for career advancement. It is recommended that students who plan to enroll in this course do so the semester following completion of Chemistry 201.

REQUISITES:

Prerequisite:
CHEM 201 with a grade of "C" or better, or equivalent. &
CHEM 201L with a grade of "C" or better, or equivalent. &
MATH 150 with a grade of "C" or better, or equivalent.

Advisory:
ENGL 101 with a grade of "C" or better, or equivalent. or Assessment Skill Level R6/W6 or
ENGL 105 with a grade of "C" or better, or equivalent.

FIELD TRIP REQUIREMENTS: May be required

TRANSFER APPLICABILITY: Associate Degree Credit & transfer to CSU and/or private colleges and universities
IGETC
UC Transfer Course List
CSU General Education

CAN DATA: CAN CHEM 12 = CHEM 251 (City,Mesa)

LECTURE HOURS PER WEEK: 3

LAB HOURS PER WEEK: 6

STUDENT LEARNING OUTCOMES:
Upon successful completion of the course the student will be able to:

1. Calibrate volumetric glassware including pipettes and flasks.
2. Analyze uncertainties in laboratory data using appropriate statistical formulas, methods and tests including standard deviation, confidence intervals, propagation of uncertainty, the Student's t test, the F test and the Q test.
3. Determine the uncertainties in the slope and intercept of a best fit line using linear regression analysis done with a computer spreadsheet program such as EXCEL.

4. Perform calculations on reactions involved in simultaneous equilibria.

5. Conduct a variety of experiments involving volumetric titrations and analyze the resultant data.

6. Conduct an experiment utilizing gravimetric analysis methods and analyze the resultant data.

7. Compare and contrast the operation of various types of electrodes.

8. Conduct experiments related to spectrophotometry including constructing calibration curves and determining unknown solute concentrations in simple solutions and mixtures using Beer's Law.

9. Explain the processes of absorption and emission of light in relationship to UV/VIS, atomic absorption and atomic emission spectroscopy.

10. Describe the function and components of spectrophotometers.

11. Explain the functions of chromatographic mobile and stationary phases.

12. Compare and contrast different types of chromatography.

13. Perform calculations involving the efficiency of separation on chromatograms including resolution and number of theoretical plates and list the factors that effect chromatographic separation.

14. Conduct a chromatography experiment on a mixture.

15. Describe the function and components of chromatography instrumentation.

16. Maintain a clearly written laboratory notebook as an annotated record of progress through standard experimental protocols, as a permanent record of experimental results, and as a journal of critical thoughts related to experimental outcomes and the general laboratory experience.

17. Write formal laboratory reports.

18. Properly calibrate and utilize common laboratory instruments including pH meters, analytical balances and spectrophotometers.

SECTION II

1. COURSE OUTLINE AND SCOPE

A. OUTLINE OF TOPICS:
The following topics are included in the framework of the course but are not intended as limits on content. The order of presentation and relative emphasis will vary with each instructor.

I. Measurement: Review
   A. Concentration units: molarity, %, ppm
   B. Preparing solutions
   C. Solutions and stoichiometry

II. Basic Laboratory Techniques and Equipment
   A. Balances
   B. Filtration
   C. Drying
   D. Calibration of volumetric glassware
   E. Extraction
   F. Gravimetric analysis

III. Data Analysis
   A. Graphing, linear regression
   B. Experimental Error
      1. Significant figures
      2. Types of error: random and systematic
      3. Propagation of uncertainty
      4. Errors in slope and intercept: regression analysis using spreadsheet programs
   C. Statistical Analysis of Data
      1. Gaussian distribution
      2. Standard deviation
3. Confidence intervals  
4. Statistical Tests  
   a. Student's t  
   b. F test  
   c. Q test  

IV. Calibration Methods  
   A. Calibration Curves  
   B. Standard Addition  
   C. Internal Standards  

V. Acids / Bases: Review  
   A. pH  
   B. Strong acids / bases  
   C. Weak acids / bases  

VI. Equilibrium  
   A. Basic concepts  
   B. Activity coefficients  
   C. Simultaneous equilibria  
      1. Charge balance  
      2. Mass balance  
   D. Dependence of solubility on pH  

VII. Volumetric Analysis: Titrations  
   A. Acid / base titrations  
   B. Compleximetric titrations  
   C. Redox titrations  
   D. Spectrophotometric Titrations  

VIII. Electrodes and Potentiometry  
   A. Electrochemistry  
   B. Junction potential  
   C. Electrodes  

IX. Spectrophotometry  
   A. Properties of light  
   B. Absorption and emission  
   C. Beer-Lambert Law  
   D. UV-Visible Spectrophotometry  
      1. Calibration curves  
      2. Analysis of mixtures  
      3. Spectrophotometers  
         a. Light sources  
         b. Monochromators  
         c. Detectors  
   E. Atomic Spectroscopy  
      1. AAS  
      2. AES  
      3. Instrumentation  
         a. Atomization: flames, furnace and plasmas  
         b. Light sources and detectors  

X. Chromatography  
   A. Theory  
      1. Mobile phase  
      2. Stationary phase  
      3. Theoretical plates  
   B. Gas chromatography  
      1. Theory  
      2. Instruments and Experiments  

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XI. Various Laboratory Experiments will be performed covering these topics:
   A. Volumetric Analysis
   B. Gravimetric Analysis
   C. Spectrophotometry
   D. Chromatography

B. Reading Assignments:
Reading assignments are required and may include but are not limited to, the following:

I. Appropriate readings from the required textbook.
II. Appropriate readings from the laboratory manual.
III. Instructor packets containing handouts or articles clarifying course objectives. For example these may include a handout clarifying propagation of random error or a handout discussing and illustrating instrument components.
IV. Articles from periodicals or web sites describing the use of analytical techniques in environmental science, medicine, forensics, geology, astronomy, etc.

C. Appropriate Outside Assignments:
Outside assignments may include, but are not limited to, the following:

I. Formal laboratory reports.
II. Short form lab reports in which the student reports mainly quantitative results such as the percent of analyte in an unknown.
III. Analyzing data generated in the laboratory using a computer program such as Excel.
IV. Problem solving exercises assigned from the textbook, study guide, and/or instructor packets. For example, exercises such as: analysis of example data by statistical means, or calculation of concentrations of substances involved in simultaneous equilibria.
V. Assignments from a CD-ROM or website that accompanies the textbook.

D. Writing Assignments:
Writing assignments are required and may include, but are not limited to, the following:

I. Maintaining a detailed lab notebook including descriptions of laboratory procedures, protocols, observations and conclusions.
II. Writing formal laboratory reports that include abstract, methods, results, discussion and conclusion sections.
III. Composing a short paragraph response which explains a principle outlined in the objectives such as explaining the process of emission and absorption of light.

IV. Composing a multi-paragraph essay which details a principle outlined in the objectives such as comparing and contrasting different types of chromatography.

V. Writing a research paper on a topic related to analytical chemistry such as forensics or natural products analysis.

E. Appropriate Assignments that Demonstrate Critical Thinking:
Critical thinking assignments are required and may include, but are not limited to, the following:

I. Determining the type of data needed to be collected for a particular experiment and then collecting it in a notebook.

II. Determining what preparations need to be done for a particular experiment and then carrying them out such as preparing solutions and calibrating instruments.

III. Writing a formal laboratory report that reflects the student's ability to analyze data and draw conclusions.

IV. Utilizing methods introduced in the beginning of the course such as linear regression and error propagation to analyze data gathered throughout the semester.

V. Problem solving exercises assigned from the textbook, study guide, and/or instructor packets. For example, exercises such as choosing which statistical test is appropriate for analysis of example data or which chromatographic method would best separate a given mixture.

VI. Discussing in class or orally presenting a current topic related to course objectives as assigned from such journals as Scientific American or Science. For example, a student could present a practical application of chromatography such as air pollution analysis.

2. METHODS OF EVALUATION:
A student's grade will be based on multiple measures of performance unless the course requires no grade. Multiple measures may include, but are not limited to, the following:

I. Formal laboratory reports.

II. Accuracy of results in determination of chemical unknowns.

III. Exams that cover theory and calculations as presented in the course objectives and may also include details of the experiments performed.

IV. Quizzes that cover theory and calculations as presented in the course objectives and may also include details of the experiments performed.

V. Pre-laboratory and/or post-laboratory assignments related to the experiments performed.

VI. Outside assignments such as the written assignments and critical thinking assignments detailed above.

VII. Student presentations to the class.

VIII. Evaluation of a lab notebook.

3. METHODS OF INSTRUCTION:
Methods of instruction may include, but are not limited to, the following:

* Computer Assisted Instruction
* Lecture Discussion
* Discussion Seminar
* Audio-Visual
* Collaborative Learning
* Lecture-Lab Combination
* Other (Specify)
* Chemical demonstrations.
  * Demonstration of laboratory equipment.

4. REQUIRED TEXTS AND SUPPLIES:
Textbooks may include, but are not limited to:

TEXTBOOKS:

MANUALS:

PERIODICALS:

SOFTWARE:

SUPPLIES:
1. Chemistry 251 Laboratory Packet
2. Laboratory Notebook
3. Scientific Calculator
4. Z-87 Chemical Splash Goggles

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